deavouring to effect a compromise between purely elementary works on astronomy and advanced treatises, it is worthy of some praise. With the many remarkable developments of astronomical science during the last quarter of a century, the bulk of the original volume has been somewhat increased by additions, and it has now been decided henceforth to publish the work in three divisions, viz.—

(1) The sun, planets, and comets.
(2) Instruments and practical astronomy.
(3) The starry heavens.

The first division of the work is now before us, and viewed as a handy book of reference it has many commendable features; but all that could be said in its praise would be the reiteration of comments upon former editions.

The most important application of spectroscopy to astronomy is too well known to need any enlarging upon. It may be said to be almost entirely a creature of the last quarter of a century, but by far the greater amount of this spectroscopic work has been directed to the sun, whilst many new and important discoveries have been made in connection with it. In pre-spectroscopic times a spot on the sun was only that, and nothing more; and a solar prominence was a stupendous flame, the observation of which was only possible at eclipses. Nothing was known of their constitution; and, in fact, all we now know of the physical and chemical condition of the sun has been gained by spectroscopists. However, it is not necessary here to consider the enormous work that has been done in this direction, but it is our duty most emphatically to protest against a compilation such as the one before us—purporting to be a completely revised account of astronomical labours and advances, and yet rendering terribly conspicuous by its absence everything that relates to spectroscopy. It is like a book on locomotion leaving out all about railways because they were not prominent when the first edition was published. The pictorial representations of the corona, the solar prominences, the surface of the sun and the spots upon it, are well discussed in their respective sections, but no room has been given to an examination of their constitution by means of the spectroscope; and indeed, as far as this book is concerned, the whole work that has been done in connection with solar physics might have been left undone.

But these remarks apply not only to the chapters relating to the sun; those on the planets and comets respectively are in the same incomplete condition. Without the spectroscope, the source of luminosity of a comet was far beyond human ken, and its whole constitution was a matter of considerable doubt; with this instrument, however, much has been added to our knowledge—the comet's light has been analyzed, and the whole sequence of changes, as it goes from aphelion to perihelion and back again, is now understood. Yet the spectroscope might never have been turned to these bodies, or indeed utilized in any way, if the utility and importance of the work done were measured by the brief notice with which the author has seen fit to dispose of it, and the following may be said to be the reason for his grievous omissions:—

"The study of the sun has during the last few years taken a remarkable start, owing to the fact that, by the aid of the spectroscope, we have been enabled to obtain much new information about its physical constitution. The subject being, however, a physical rather than an astronomical one, and involving a great amount of optical and chemical details, it cannot conveniently be discussed at length in a purely astronomical treatise, though something will be said concerning it later on in the portion of this work dedicated to spectroscopic matters."

This explanation, however, only aggravates the fault. The importance of the work that has been done is assented to, but, instead of including that part of it relating to the sun in a chapter on that body, instead of considering the spectroscopy of comets as inseparable from a chapter devoted to their discussion, the author has relegated the whole work to an unpublished section devoted to astronomical instruments. Such an arrangement is undoubtedly wrong. A chapter on the sun must contain all that is known about that body, if it strives to be at all complete; similarly, a chapter on comets cannot approach completion unless their spectra are considered; thus this work cannot lead the general public to a just appreciation of the many advancements that have been made. The most elementary text-books rightly include the spectroscopic labours and discoveries, whereas this so-called hand-book, although aiming at being an historical account of the work that has been directed to the sun, planets, and comets respectively, leaves a vast array of facts out of consideration altogether.

There are a few minor faults, one of which is the figure relating to Foucault's pendulum experiment for determining the rotation of the earth. The author appears to have discarded the method of suspension adopted by Foucault, and the pendulum is sketched as if rigidly attached to a beam. The accompanying text also leaves this most important experimental detail out of consideration.

But apart from these points, the work is worthy of some commendation. An addition has been made to the chapter on comets, viz. a method of determining the elements of the orbit of a comet by a graphical process. The catalogue of comets whose orbits have been computed has also been brought up to date, and similar additions have been made to the chapters on periodic and remarkable comets. Doubtless the book will prove to be what it has been heretofore—a handy reference to some astronomical facts.

ELECTRICAL UNDERTAKINGS.

Proceedings of the National Electric Light Association at its Ninth Convention, 1889. Vol. VI. (Boston, Mass., U.S.: Press of *Modern Light and Heat*, 1889.)

WE have before us, in this volume, an account of the proceedings of the National Electric Light Association in the United States during the Convention held at Chicago on certain days in February 1889.

This body is one which, in the United States, has been brought into existence by the growing necessities and rapid expansion of the electric light and power industry. Probably its nearest English analogue is the Iron and Steel Institute. It is essentially a commercial association, and its aims may be said to be comprised within the limits of the exchange of practical information

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amongst its members, and of such joint action as will further the use and success of these electrical trades. Hence its objects are not, exactly speaking, scientific, at least in the usual sense of the word, and the intermixture of genuine desire to exchange veritable experience, with a certain element of effort to push into notice particular personal "interests," renders a discriminating mind necessary in dealing with its Reports. At the time of writing, when the work of practically providing London with distributed electric current is being carried on with energy in diverse directions, and the various Electric Supply Companies are laying down mains and establishing stations, this Report serves a useful purpose of enabling us to judge the present state of the industry in the country where, of all others, it has had the most unhindered development.

In his opening address, the President, Mr. S. A. Duncan, gave some figures which are significant of the immense extent to which the electric lighting business has now progressed in the United States. The total number of arc lights in daily use is about 220,000; of incandescent lamps, some 2,500,000. There are approximately 5700 central stations and isolated plants, supplying electric current to single buildings or groups, or sections of towns. There are 53 electric railways in operation, and 44 in progress, on which 378 electric tram-cars travel over 294 miles of track. The total capital employed and sunk in these various undertakings is probably not under fifty millions sterling. When we consider that this is the growth of ten years, we are bound to admit, not only that this youngest of the applied sciences is of vigorous growth, but that its commercial basis must be sound. The Proceedings of the Convention take the form of a series of Reports on various points of interest which are drawn up by individuals or Committees, and then discussed by the whole body.

One of the important questions which in this meeting received consideration was that of underground conductors. It has been evident for a long time that arc-light wires, telephone, telegraph, fire-signal, and incandescent-lamp wires cannot be permitted to increase without limit in the form of overhead conductors. In the early days of the telephone and arc light the inconvenience of overhead wires did not present itself as a formidable one; but, with their rapid growth, the dangers to life and property arising from an indiscriminate collection of electric wires strung on poles or attached to roofs in large cities became apparent. Hence has arisen a demand that they shall be put underground.

Unfortunately this is not so easy in practice as it seems. The distributing companies in many cases desire to avoid the cost of making the exchange in those cases in which they are operating overhead wires. The expense of an underground system of conductors is from five to ten times that of aërial lines. Moreover, the various methods suggested for sub-laying the conductors in streets and roads have all peculiar merits and demerits. Mr. Edison, as is well known, places the copper conductors in steel pipes, insulating them with a bituminous compound, and lays these like gas-pipes in the streets. This system has been operated for years in New York, Milan, Boston, and Chicago, with a high degree of success. Other inventors have advocated a conduit system; others, again, the use of bare copper conductors insulated in a subway. It is thus seen that the necessary experience for satisfactorily laying down underground systems of conductors for the conveyance of large electric currents is only slowly being collected.

The city of Chicago has one of the most completely developed systems of underground conductors for arc-light wires. There are some seventy-eight miles of underground cable conveying currents under a pressure of 1000–1800 volts. The members of the Convention not unnaturally exhibited considerable differences of opinion on this question of underground conductor systems. A Committee appointed for the purpose had issued a circular to about 1066 managers of central stations and lighting systems and others, with the object of eliciting their opinions on the subject of underground conductors. Out of this number 130 returned very full answers to the various questions, and the diversity of opinion seems very great. It is difficult, however, to believe that the process of collecting information was that which would lead to the best results, and although the various views put forward in the discussion on the Report are interesting, they do not indicate a solidarity of opinion on any one point. It is perfectly certain, however, that in England electric conductors for systems of town lighting by electricity will have to be placed underground, and it is also equally certain that those responsible for this work will have to exercise the greatest discretion and take the fullest advantage of existing experience. The question of the fire risks of electric lighting also occupied the attention of the members. In the United States, as with us, the opinion based on experience is that when the work of installing the electric light is carried out under all known proper precautions, and by the best guidance, there is greater safety in it than in gas illumination, but that when these known precautions are disregarded then danger ensues. Minor questions, such as the disruptive discharges in lead cables and fuel oil, attracted briefer attention. The importance of such a gathering in guiding the experience of those who are fostering an industry like that of electric lighting, in which invention advances by leaps and bounds, is very great. We in England, thanks to the revision of the Electric Lighting Act, are now entering on a period of great electrical activity, and already it has been found that the commercial side of electrical engineering requires the association of those engaged in it for mutual advice and joint action, and the London Chamber of Commerce has now an active Electrical Section which fulfils to some extent the functions of the National Electric Light Association in America.

J. A. F.

DIANTHUS.

Enumeratio Specierum Varietatumque Generis Dianthus. Auctore F. N. Williams, F.L.S. Pp. 23. (London: West and Newman, 1889.)

ONE of the things most wanted by species-botanists at the present time is a set of monographs of a number of the familiar large genera of Polypetalous Dicotelydons. The natural orders of Polypetalæ were

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